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Gemini Launch Vehicle Pilot Safety Program

JANUARY 1963

Prepared by GEMINI LAUNCH VEHICLE DIRECTORATE, SSD and
GEMINI LAUNCH VEHICLE PROGRAM OFFICE, AEROSPACE CORPORATION

Prepared for COMMANDER SPACE SYSTEMS DIVISION
UNITED STATES AIR FORCE
Inglewood, California

ENGINEERING DIVISION • AEROSPACE CORPORATION
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PILOT SAFETY PROGRAM

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FOREWORD

The Pilot Safety Program for the Gemini Launch Vehicle System exists for two reasons. First, SSD and Aerospace share a deep concern for the safety of the Gemini Astronauts, and feel the need for a program whose specific objective is to provide optimum pilot safety. Second, the decision to commit a manned booster to launch is a heavy burden, which can be made with confidence only after SSD and Aerospace have assured themselves that everything reasonable has been done to safeguard the Astronauts.

Concern for the safety of the Astronauts is not the exclusive prerogative of the Pilot Safety Program. On the contrary, such concern shall permeate all plans and activities, and motivate all personnel and organizations supporting Gemini. In fact, the major function of the Pilot Safety Program is to ensure that this concern for safety is manifested in other plans, reflected in appropriate activity, adequately documented, and thoroughly assessed prior to launch.

The Mercury/Atlas Booster program has demonstrated the feasibility as well as the problems of transforming an unmanned weapon system into a manned booster. It is significant that much of the Mercury success is attributed to its Pilot Safety Program and adherence to its unified philosophy and procedures. The GLV Pilot Safety Program is based upon the Mercury experience but with the special problems inherent in a different booster system.

This GLV Pilot Safety Program document will be implemented by SSD and Aerospace, and will guide all contractors and agencies supporting the Gemini Launch Vehicle program during implementation of their specific contractual tasks.

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PART I -- GENERAL

SECTION 1. -- BACKGROUND

1.1. Fundamental to the Mercury and Gemini Launch Vehicle programs is the adaptation of a weapon system to meet the requirements for boosting a manned spacecraft into earth orbit. The Atlas D and Titan II were both conceived and developed as ballistic weapon systems; as such they were not designed in accordance with the mechanical limits, reliability criteria, and safety considerations normal for piloted aircraft. Moreover, the potential reliability of these systems was designed into the equipment on weapon system programs and can be significantly improved now only with major design modifications. The Titan II is the most reliable proven booster available in the time period, and by DOD-NASA agreement modifications will be held to a minimum consistent with reliability objectives.

1.2. To assure realization of the maximum reliability available in the basic design of the Atlas/Mercury booster, and to supplement this with a highly reliable abort system, AFBMD and STL instituted a Pilot Safety Program for Mercury. This program was continuously refined and improved as a team effort between SSD, Aerospace Corp, Associate Contractors and NASA. Today it provides the unifying philosophy and major documentation framework for the Mercury Booster Program.

1.3. The NASA-DOD Operational and Management Plan, dated 29 Dec 1961, directed Gemini to establish a Pilot Safety Program similar to that used by Mercury. SSD/Aerospace have implemented this requirement by ensuring that the plans and specifications for Gemini are consistent with the requirements of a manned booster.

SECTION 2. -- OBJECTIVES

2.1. The prime objective of the GLV Pilot Safety Program is to assure Astronaut safety by provision of a reliable booster. A further objective of the program is to assure adequacy of the GLV Malfunction Detection System (MDS) with the abort capability in the event of booster failure.

SECTION 3. -- ASSURANCE

3.1. Prior to committing the GLV to launch, SSD and Aerospace intend to leave nothing undone that can reasonably enhance the Astronauts' safety. Assurance that nothing has been neglected can be provided only by following a pattern of rigorous technical monitoring of associate contractor activity; rigid control of all phases of design, development, engineering changes, production, inspection, testing, handling, acceptance, and launch; emphasis on configuration documentation and verification control; and extensive data and procedural reviews. To provide adequate confidence for a Gemini launch, SSD will require a significantly greater depth of assurance of booster readiness than normally achieved with unmanned missile and space vehicles.

SECTION 4. -- IMPLEMENTATION

4.1. The GLV Pilot Safety Program will be implemented in two ways. First, the program will ensure a continuous monitoring effort, commencing with the preliminary design and continuing through launch. Second, the program will concentrate considerable effort at key focal points and when major problems arise.

4.2. Responsibility for the Pilot Safety Program shall rest at Program Director level. The program will encompass all GLV activities and permeate all work levels.

4. 3. The Manned Flight Surveillance Board (MFSB) shall constitute the major top-level Air Force management board for the GLV program. This board shall be convened at SSD discretion to discuss and resolve critical technical problems which have a major effect on the GLV program and/or threaten Astronaut safety. The MFSB shall be composed of the following, or of those requested by the Chairman:

Chairman.	. Deputy for Engineering, SSD	
Members.	. Director, GLV Directorate, SSD	
	System Engineering Director, Aerospace Corp	
	Top level management representatives from GLV associate contractors as appropriate (i.e. President, Vice-President, Program Director, Chief Engineer, etc. level)	
	Commander, 6555th ATW Director, Aerospace AMRO BSD Representative	When requested by the Chairman

PART II -- PRE-LAUNCH

SECTION 5. -- DESIGN AND DEVELOPMENT

5.1. Reliability and Qualification. The GLV program will include as a minimum:

a. Documented system, subsystem, and critical component reliability studies to include all known or potential problems, probability of failure, modes of failure, and recommended corrective action.

b. Documented design reviews for selected critical components as required by SSD/Aerospace.

c. A failure reporting and failure analysis system providing for prompt corrective action.

d. A component test program. All launch vehicle components will be qualified prior to first GLV launch.

5.2. Malfunction Detection System. The MDS will receive special consideration throughout design, development, and test to make sure it provides a reliable input to the abort system. Provision of accurate, reliable malfunction warning to the Astronauts is first priority. The Titan II "Piggyback" program will provide technical evaluation of the GLV MDS under open-loop flight environment. Such evaluation must be satisfactorily completed prior to first manned GLV launch.

5.3. Titan II/Gemini Interdependence. SSD will insure that there is a complete and timely interchange of information between the Titan II and Gemini Programs. All Titan II experience (i.e., checkout procedures, failure data, maintenance problems, countdown abnormalities, etc.) shall be available to the GLV program. SSD/Aerospace will establish a system whereby each Titan II launch is reviewed in detail for its potential effect on the Gemini Program. Telemetry data will be reviewed by the associate contractor(s), and the report assessed

by Aerospace for SSD. Experienced environmental conditions will be compared with established qualification requirements. The design of the GLV MDS, in particular, will be evaluated to determine if a false signal would have been initiated by the GLV, if GLV sensing coverage would have been adequate, and if a GLV MDS warning would have been timely.

SECTION 6. -- CONFIGURATION CONTROL

6.1. A comprehensive configuration, identification, control, and accounting system shall cover all airborne systems, AGE, and facilities. A baseline configuration will be established for the first GLV and each initial AGE item (including engines, guidance, Mistram, etc.), after which all Class 1 changes must be approved by SSD/Aerospace. Class 2 changes must be reviewed by the appropriate AFPR prior to production release.

SECTION 7. -- FABRICATION

7.1. Quality Assurance. A quality assurance program in considerably greater depth than usually associated with ballistic missile and unmanned space hardware will be enforced. Minimum requirements are:

a. A comprehensive education and motivation program designed to stimulate pride of good workmanship.

b. A limited component selection program.

c. A component identification program.

d. Special handling procedures.

e. Comprehensive inspection (as considered necessary by SSD/Aerospace) of piece parts, critical components, materials, processes, and procedures.

7.2. Indoctrination. Lectures will be given to selected groups of manufacturing, inspection, and test personnel, both at contractor facilities and AMR, emphasizing the significance of the program,

pointing out the critical need for high quality, and describing the special steps to be taken in all phases of the contractors' activities. Senior quality control representatives of selected sub-contractors producing critical components used by Gemini will be familiarized with the overall program, the role of the GLV, and that of their own products in the program. Special inspection stamps, badges, posters, Gemini stickers, etc. will be used wherever appropriate to motivate GLV personnel.

7.3. Component Control. Components will be rejected in all cases where successful flight performance is in doubt. A component which has had an unexplained transient nonrecurring malfunction, excessive repair or refurbishing, or excessive operating time will not be used for flight. Limited special selection of GLV piece parts and components may be required by SSD when such selection contributes significantly to pilot safety. Selection criteria may include nominal performance, predetermined operating times prior to acceptance, clean inspection records, consistent behavior, etc.

7.4. Special Requirements. SSD/Aerospace may require that selected hardware, and its associated logs, or test data be reviewed in detail before incorporation into the GLV or engines. For example, the tanks will not be shipped from Denver prior to SSD/Aerospace review and approval of the repairs and problem areas.

7.5. Test. SSD/Aerospace will ensure that component, sub-system, system, and vehicle test programs are adequate for the GLV manned mission. SSD will extend or revise the test program whenever necessary to provide optimum pilot safety.

SECTION 8. -- ACCEPTANCE

8.1. General. SSD/Aerospace will focus intense inspection team effort during the acceptance phase. Hardware will not be accepted until SSD/Aerospace are convinced that the hardware and documentation comply with appropriate specifications and other contractual requirements, and meet the requirements for the GLV manned mission.

Acceptance will be characterized by a methodical approach and an uncompromising attitude.

8.2. Acceptance Teams. SSD/Aerospace will establish acceptance teams consisting of members from SSD, Aerospace, AFPR, 6555th ATW, AFSCTSO, Aerospace/AMRO, as required. The acceptance team captain shall be the Director, GLV Directorate, SSD, or his designated representative. The composition of the teams will remain as stable as possible and will include the most technically qualified personnel available. NASA will be invited as observers. An acceptance team will be assigned to Martin-Baltimore for the launch vehicle, to Aerojet-Sacramento for the engines, and to other major acceptance areas as required by SSD/Aerospace.

8.3. Hardware Monitorship. SSD/Aerospace and Air Force Quality Control staffs (especially members of the acceptance team) will follow the hardware development and fabrication in sufficient detail so that they are familiar with its history and problem areas. Throughout the program the Associate Contractors shall adequately document the problem areas encountered. These will be discussed with SSD/Aerospace by the contractor concerned, and every effort shall be made to resolve discrepancies prior to initiation of the acceptance testing.

8.4. Acceptance Tests. The Associate Contractor shall present the status of all required documentation and test data to the AFPR prior to commencing final acceptance tests. If the data and documentation are acceptable, the AFPR will give approval for the Associate Contractor to perform the final acceptance tests under Air Force monitorship. The procedures, specifications, and documentation and data requirements for the Acceptance Team Review will be stated in detail by contractual documents.

8.5. Contractor and AFPR Review. Following completion of the final acceptance test(s), the data will be reviewed independently by the Associate Contractor concerned for compliance with GLV requirements. If further work or tests are necessary, the contractor will perform such work or tests with the approval and under the monitorship of the AFPR. When the contractor is satisfied, the data and log records from the acceptance test(s) shall be reviewed by the AFPR. The AFPR may direct further work or tests until assured that the hardware meets specifications and documentation is complete. Review of test data and evaluation of hardware documentation will be conducted sequentially (not in parallel) to ensure that the Associate Contractor, AFPR, and the Acceptance Team establishes an independent position.

8.6. Acceptance Team Review. The Acceptance Team will then conduct a comprehensive review of the hardware logs and test results, may observe runs or direct re-runs of critical tests, and may spot-check hardware or tests at its discretion. The team will assure itself that tests and documentation are meaningful, and that hardware has not been degraded by the tests. The team will ascertain that the following criteria are met prior to acceptance:

a. Completion of satisfactory component, sub-system, system, and all acceptance tests.

b. Completion of accurate documentation of the hardware status to include the entire history and identification of components by serial number (including spares), component and sub-system selection criteria if applicable, test data, status of engineering change proposals, and problem areas encountered.

c. Completion of a detailed report covering the status of critical components.

d. No functional shortages (including instrumentation) of operating components or of specified spares.

8.7. Acceptance. The hardware will remain in the final acceptance test fixture until released by the acceptance team captain. The captain

will make a final decision to accept or reject the hardware. In the case of rejection, he will advise AFPR and the Associate Contractor of the reasons for rejection and the requirements for further tests or documentation. If the hardware is accepted, the contractor will be advised of any additional tasks to be accomplished, and the AFPR will take the contractually specified steps to accept the hardware.

SECTION 9. -- TRANSPORTATION

9.1. SSD may direct the Associate Contractor to provide special handling, chaperone services, accompanying documentation, etc. to ensure that the hardware reliability and quality are maintained at the high level required by the GLV manned mission during the transportation phases.

SECTION 10. -- ATLANTIC MISSILE RANGE (AMR).

10.1. General. Gemini will follow generally the Mercury/Atlas Pilot Safety philosophy and procedures used at AMR, although full use will be made of established operating procedures and practices developed for the Titan II AMR flight test program. The GLV Pilot Safety program at AMR will be implemented by: (1) a Quality Assurance effort, (2) a Flight Readiness effort, and (3) a Flight Safety Review. The document "AMR - GLV Pilot Safety Program", as approved by SSD, shall define the coordination, documentation, procedures, inspections, and responsibility aspects of the Quality Assurance effort; and the composition, responsibility, authority, and activity of the various teams involved in the Flight Readiness effort.

10.2. Quality Assurance Effort. The Quality Assurance effort will assure that the quality, workmanship, and reliability (which have been incorporated into the GLV during preceeding phases) are maintained throughout the AMR activities. This effort will embrace all GLV hardware (including AGE and launch facilities) and documentation, and includes the selection, identification, handling, storage, and documentation of spare parts for the GLV.

10.3. Flight Readiness Effort. The Flight Readiness effort will provide positive control over AMR GLV activities (including the spacecraft interface), and will determine the flight readiness of the launch vehicle and its compatability with the launch complex, AGE, and spacecraft. Those assigned to this effort will be the best qualified personnel available at AMR, and a vigorous effort will be made to maintain stable assignment of such personnel.

10.4 Flight Safety Review. The Flight Safety Review, as conducted by the Flight Safety Review Board (FSRB), will constitute the final, focal-point activity of the Pilot Safety program. The FSRB will satisfy itself as to the status of the launch complex, AGE, and GLV (including the GLV-spacecraft interface), and will make the ultimate decision as to whether or not to commit the GLV to launch. While NASA may decide at any time to cancel the launch, no agency may commit the GLV to launch without the approval and concurrence of the FSRB.

10.5. Flight Safety Review Board (FSRB). The FSRB will be composed of the following, or their designated representatives:

Chairman. . . Commander, SSD

Members . . . Deputy for Engineering, SSD
Commander 6555th Aerospace Test Wing
President, Aerospace Corporation
Director, Aerospace AMRO

Observers . . DOD Representative
NASA Team (to include the Operations Director and an Astronaut).

Recorder . . . Furnished by GLV Directorate, SSD.

10.6 FSRB Activity. The FSRB will assemble at X-1 day, or as directed by the Chairman, to conduct the Flight Safety Review. The Director, GLV Directorate, SSD will prepare and/or coordinate a presentation to the FSRB to include the following:

a. Significant details of previous GLV and Titan II launches.

b. Modifications to hardware, profile, and procedures since previous launch (or since previous review by the FSRB).

c. History of the GLV through production to arrival at AMR.

d. History of the GLV at AMR.

e. Report and recommendations of the GLV Status Review Board.

f. Complete technical review of the significant problem areas.

g. Report on personnel changes of the launch crew and the flight readiness teams.

Following the presentation, the Chairman will provide an opportunity for hearing dissenting or qualifying statements. The FSRB will then decide whether or not to commit the GLV to launch, and present this decision to the senior NASA representative for his concurrence or rejection. The NASA and DOD Observers are invited to participate fully in the above Review to assure themselves as to the GLV status.

PART III -- POST-LAUNCH

SECTION 11. - NORMAL

11.1 The document "AMR - GLV Pilot Safety Program" will define the pilot safety activity at AMR following a normal launch. In general, the Test Director, 6555th ATW, will provide a review of the major launch highlights shortly after the launch. Additionally, SSD/Aerospace will conduct a preliminary review of the telemetry data shortly after it is available.

SECTION 12. - ACCIDENTS

12.1. In the event of major launch abnormalities, and especially in the case of flight failure of the GLV, the Chairman of the Flight Safety Review Board will immediately reconvene the FSRB at AMR. This board will review the abnormality and decide on an investigatory coarse of action. The FSRB will normally convene the Manned Flight Surveillance Board (MFSB) and direct its scope and activity. NASA will be invited to participate fully as an observer during any investigations by the MFSB or the FSRB.

REFERENCES

Further details of the Pilot Safety Program will be covered in the following documents:

a. Martin GLV Acceptance Procedures to implement MB-1049.

b. Aerojet Procedures to implement AGC 46503/AGC 46502.

c. General Electric Procedures to implement Specifications No. 7523059, 7523060, and 7523061.

d. Martin Acceptance Procedures to implement MB-1050 (AGE)

e. AMR - GLV Pilot Safety Program.